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Proceedings of the regional peer review of the Newfoundland and Labrador Snow Crab assessment for areas 2J3KLNO 3Ps and 4R

February 18-20, 2014
St. John's, NL

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

A meeting of the Newfoundland and Labrador (NL) regional peer review process (PRP) on Snow Crab was held February 18-20, 2014 in St. John's, Newfoundland. Its purpose was to assess the status of the Snow Crab resource in Northwest Atlantic Fisheries Organization (NAFO) Divisions (Div.) 2HJ3KLNO, Subdivision (Subdiv.) 3Ps, and Div. 4R.

A Science Advisory Report (SAR) was written and reviewed in meetings during February 25, 26 and 28, 2014 (which was originally scheduled on February 25-27, 2014). It includes overall and division-by-division summaries for crab, which were written and reviewed at the meeting. Detailed rapporteur's notes of discussion on each working paper presented at the meeting, in question-and-answer/comment-and-response form, were produced. This Proceedings Report includes an abstract and summary of discussion for each working paper presented, and a list of research recommendations from this meeting.

Compte rendu de l'examen par des pairs de l'évaluation du stock de crabes des neiges de Terre-Neuve-et-Labrador

SOMMAIRE

Une réunion du processus régional d'examen par les pairs de Terre-Neuve-et-Labrador sur le crabe des neiges et le buccin a eu lieu du 18 février au 20 février 2014 à St. John's, à Terre-Neuve-et-Labrador. Le but de cette réunion était d'évaluer les stocks de crabes des neiges dans la division 2HJ3KLNO, la sous-division 3Ps et la division 4R de l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO).

Un avis scientifique (AS) a été rédigé et examiné lors de réunions qui ont eu lieu du 25, 26 et 28 février 2014 (prévu à l'origine du 25 au 27 février 2014). Cet avis comprenait des résumés des stocks de crabes (pour l'ensemble des divisions et propres à chaque division) qui ont été rédigés et examinés lors de la réunion. Les notes détaillées du rapporteur sur les discussions tenues pour chacun des documents de travail ont été présentées lors de la réunion, sous forme de questions-réponses/commentaires-réponses. Ce compte rendu comprend un résumé et un sommaire des discussions liées à chaque document de travail présenté, de même qu'une liste des recommandations relatives à la recherche.

INTRODUCTION

A meeting of the Newfoundland and Labrador peer review process on Snow Crab (*Chionoecetes opilio*) was held from February 18 - 20, 2014 in St. John's, Newfoundland and Labrador (NL) to assess the status of the Snow Crab resource in NAFO Divs. 2HJ3KLNOP4R. Terms of reference, the agenda, the list of participants, and working papers presented at the meeting are provided in Appendices I through IV, respectively.

Participation included personnel of Fisheries and Oceans Canada (DFO) Science and Fisheries Management Branches (Newfoundland and Labrador Region), representatives from the fishing industry, Provincial Department of Fisheries and Aquaculture, Academia, First Nations groups and other invited experts.

Open discussion and debate proceeded during and after each presentation. At the meeting, consensus was reached on summary bullets of results of the overall Snow Crab assessment for the division-by-division assessments. These are included in a SAR written and reviewed February 25, 26 and 28, 2014.

These proceedings contain abstracts for working papers presented and summaries of the discussion on each. Additional information can be found in the Science Advisory Report (SAR) and in research documents cited or from contacts provided therein.

WORKING PAPER ABSTRACTS AND DISCUSSION SUMMARIES

OCEANOGRAPHIC OVERVIEW: PHYSICAL OCEANOGRAPHIC ENVIRONMENT ON THE NEWFOUNDLAND AND LABRADOR SHELF, UPDATE FOR 2013

E. Colbourne, J. Craig, C. Fitzpatrick, D. Senciall, P. Stead, and W. Bailey.

Presenter – E. Colbourne

Abstract

A key indicator of ocean climate conditions on the Newfoundland and Labrador (NL) Shelf, the North Atlantic Oscillation (NAO) index, returned to a negative phase in 2013 and as a result arctic air outflow to the Northwest Atlantic during the winter decreased over the previous year. This appears to have resulted in an increase in winter air temperatures over much of the Labrador Sea area causing a continuation of less sea-ice than normal on the NL Shelf. Annually, however, air temperatures decreased over 2012 but remained above the long-term mean in southern Labrador by 0.5 SD (0.7°C at Cartwright) and Newfoundland by 0.7 SD (0.7°C at St. John's). The annual sea ice extent on the NL Shelf remained below normal (1.4 SD) for the 18th consecutive year, a decrease of 0.5 SD over 2012. As a result of these and other factors, local water temperatures remained above normal in most areas in 2013 but showed a decrease over 2011-2012 values.

Average sea surface temperatures on the NL Shelf decreased from 1.6 SD above normal in 2012 to about 0.4 SD above normal in 2013 and near shore at Station 27 they were 1.1°C (1.6 SD) above normal, similar to 2012. Bottom temperatures at Station 27 were 1 SD (0.4°C) above normal nearly identical to 2012 values. Spring bottom temperatures in 3Ps decreased to about 1 SD above normal in 2012-13 down from +2 SD in 2011 and in 3LNO they decreased to slightly less than 1 SD above normal.

Fall bottom temperatures in 2J, 3K and 3LNO decreased from 2, 2.7 and 1.8 SD above normal in 2011 to 1.1, 1.2 and 0.2 SD above normal in 2012 and to 0.8, 0.5 and 0.1 above normal in 2013, respectively, a significant decrease in the past 2 years. As a result the area of bottom habitat covered by water <2°C increased to near-normal values in 2013 during both spring and fall. The area of the cold intermediate layer (CIL) water mass with temperatures <0°C on the NL Shelf during the summer of 2013 ranged from 0.5 to 1.4 SD below normal implying a continuation of less cold shelf water than normal. In general, most environmental indices show a continuation of a warmer than normal trend throughout the area. During the past 2 years however, temperatures have decreased compared to the record warm conditions of 2011.

Discussion

In the question period following the presentation, it was asserted that for Div. 2HJ3KL, Snow Crab trends in the north have been thought to precede those to the south by about one year. Though this lagged trend was hypothesized, it has not been observed in all years. For example, changes in Snow crab CPUE in 3K appeared to lag a year behind 2J in 2003 and 2004. More recently however, the lag of 3K behind 2J has not been observed.

Because bottom temperature has been found to be inversely related to snow crab CPUE, these temperature changes could be driving the observed trends in Snow Crab. Based on the oceanographic data from the Labrador shelf, it might be possible that advection could have accounted for a delay in bottom temperature trends in 3K. However the differences in bottom temperature observed between the two areas and years did not seem to be significant.

It was noted that the Atlantic Multi-decadal Oscillation (AMO) is currently in a warm phase. The onset of this phase was the late 1990s-early 2000s. Based on the trends of this cycle over the

past century, it is likely that there will be a few more decades in the warm phase before returning to the reverse cool phase.

INFERRING EXPLOITATION RATES FROM THE DISTRIBUTION OF AGES OF HARD SHELLS OF ADULT CRABS

G. Evans

Presenter – G. Evans

Abstract

Consider a group of terminally moulted ('adult') crabs of a given size. As time goes on their size will not change, their shell will get, and look, older, and their numbers will decrease. The relative proportion of shells of different ages at a given size indicates the mortality rate at that size. If the Snow Crab fishery imposes a much higher mortality on adults of legal size, this should produce a sharp increase in the proportion of young-shelled crabs at legal size compared to sublegal size. This approach, looking at large-scale patterns that would be expected to arise in the population, complements more local approaches that try to observe things as they happen. Proxy data for shell age were examined for 17 years of data from the autumn Campelen survey. They showed no sign of the expected sharp change in shell age composition at legal size. Indeed, the proportion of crabs classified as new-shelled smoothly decreased as size increased.

Possible explanations:

- 1) Fishing has no effect on the population.
- 2) Fishing affects sublegal sizes as much as legal sizes.
- 3) Natural mortality decreases with size to compensate for increased fishing mortality (though it would not make a compensatory STEP at legal size).
- 4) Changes in the population over time might somehow distort the results.

Discussion

The results of this study do not conclude that fishing mortality has no effect on the snow crab population. However the analysis performed did not detect the expected sharp change in the composition of shell age in terminally moulted crabs from sublegal to legal size.

It is possible that the sampling for this study accessed more components of the population than just those that are easily captured by the commercial fishery. However, the lack of a fishery induced step in the shell-age composition was observed even in areas where local harvesters are struggling to reach their quotas. In areas where both effort and fishing mortality are expected to be high, it is surprising that the effect of the fishery was not detected. A research recommendation was given to try to explain this pattern. The recommendation was to focus the analysis of shell-age composition more on the survey data specifically from fished areas to attempt to zone in and find the fishery effect.

A question was posed about whether the participants in the fishery select against snow crab that are legal-size but older shell condition. The logic behind this inquiry was that perhaps these crabs would be less desirable. The response to this was that all legal-size hard-shelled male crabs are supposed to be landed. If discard of older-shelled crabs happens in practice, there is no evidence that it is a frequent occurrence.

A suggestion that the natural mortality might be higher on the small terminally moulted crab was offered as a possible generating mechanism for the pattern of decreasing proportion of new-

shelled crabs with size. Though this may be a possible explanation for the overall shell-age trend with size, it does not address the total lack of a fishery induced step in the shell-age composition at legal size.

There is still work to be conducted with this analysis (and its interpretations) in the future. Research recommendations from the group included: repeating the analysis for other stock areas, concentrating only on sites where there is an active fishery and looking for evidence of a yearly trend in the data to see if the results of the analysis are highly variable over time.

AN ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB (*CHIONOECETES OPILIO*) IN 2013: OVERVIEW OF DIVISIONS 2HJ3KLNOP4R

D. Mullowney, E. Dawe, K. Skanes, E. Hynick, W. Coffey, P. O'Keefe, D. Fiander, D. Stansbury, E. Colbourne, and D. Maddock Parsons.

Presenter – D. Mullowney

Abstract

Resource status was evaluated throughout NAFO (Northwest Atlantic Fisheries Organization) Divisions 2HJ3KLNOP4R based on trends in biomass, recruitment, production, and mortality. Multiple indices of these metrics were derived from a suite of data sources that include dockside-monitored landings, harvester logbooks, at-sea observer monitoring, pre- and post-season trawl surveys, broad-scale post-season trap surveys, localized inshore trap surveys, a vessel monitoring system (VMS), and biological and oceanographic sampling data from multiple sources. The resource was assessed separately for offshore and inshore areas of each NAFO division, where appropriate (Div. 3KLP4R). Data availability varied among divisions and between inshore and offshore areas within divisions. Trap and trawl surveys indicate that overall the exploitable biomass has changed little since the mid-2000s but that recruitment has recently declined and is expected to decline further in the short-term (2-3 years). The resource has also become increasingly concentrated into Divisions 3LNO in recent years, with about three-quarters of both the exploitable and pre-recruit biomass occurring in those divisions in 2013 post-season surveys. Long-term recruitment prospects are unfavorable in all divisions due to a recent warm oceanographic regime. Trends in indices are described in detail for each division and conclusions are presented with respect to the anticipated effects of short-term changes in removal levels on fishery induced mortality.

Discussion

A new way to illustrate and interpret the prevalence of soft-shell crab in relation to catch rates was presented in this meeting. Phase plots plotting the Catch per Unit Effort (Kg/trap of retained crabs) against the percentage of soft-shell crab observed, are divided into four quadrats using a y-axis cutting line at 7 kg/trap and an x-axis cutting line at 20 % soft-shell in the catch. These categories can be described as quadrat: A) High catch rate, low soft-shell B) High catch rate, high soft-shell C) Low catch rate, low soft-shell and D) Low catch rate, high soft-shell. When the data for an area falls into quadrat A, catch rates are fairly good and low prevalence of soft-shell is not alarming, soft-shell is rarely encountered at high catch rates. High soft-shell prevalence at either high or low overall catch rates (B or D) can be a predictor of recruitment to come, as pre-recruits are progressing toward legal-size. Low catch rate, low soft-shell (quadrant C) is the worst quadrat for the fishery data to fall into as it suggests a poorly performing fishery in the current year and low recruitment in coming years. This plot was shown for the entire NL stock and also appeared in the presentations for each individual division going forward in the meeting.

An inquiry about the utility of management divisions versus biological units was made during this discussion. In Canada, Snow crab assessment and management is conducted by management areas, and inshore versus offshore, yet the genetic evidence suggests that the resource may comprise a single stock. Discussion regarding whether management advice should be based on the biological unit before being broken down for managers on a spatial scale to allocate effort occurred. It was suggested that perhaps the amount of exchange sufficient to produce genetic uniformity may have little or no management relevance, thus assessment at the level of divisions may still be appropriate.

It was noted that in many areas it appears that the abundance of legal-sized Snow Crabs may be decreasing. Though this appears to be occurring, the data may not reflect this yet because it is being bolstered by crabs in 3LNO. A recruitment pulse that came in as small legal-size crabs in 2009 has now progressed to much larger crabs that are propping up the overall biomass.

Ontogenetic movements of male Snow Crab have been inferred from their distribution patterns, with larger crabs being distributed at greater depths than smaller crabs. Snow Crabs are believed to migrate to deeper waters as they grow. Very large crabs are found on the Div.3LNO slope, an area where smaller crabs are uncommon and this appears to be one of the longest migration routes. Based on these observations, a research recommendation was put forward to examine the following question: Given that the small crabs that happen to be located closer to ideal recruitment areas, such as deeper slope waters have a markedly shorter ontogenetic migration route, would they then be more likely to survive and recruit?

AN ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB (*CHIONOECETES OPILIO*) IN 2013: OVERVIEW OF DIVISIONS 2HJ

D. Mullowney, E. Dawe, K. Skanes, E. Hynick, W. Coffey, P. O'Keefe, D. Fiander, D. Stansbury, E. Colbourne, and D. Maddock Parsons

Presenter – D. Mullowney

Abstract

Landings decreased by 45 % since 2008, to 1,380 t. The TAC has not been taken in the past 3 years. CPUE declined steadily by half from 2008 to 2011, was unchanged in 2012, and increased in 2013. The exploitable biomass, as indicated by the post-season trawl survey, declined steadily from 2006 to 2011 and has changed little since. Recruitment declined from 2006 to 2011 and changed little since; prospects are uncertain in the short term (2-3 years). The post-season trawl survey pre-recruit index has changed little since 2005. A recent warm oceanographic regime suggests weak recruitment in the long term. The exploitation rate index increased steadily from 2007 to 2012 before decreasing in 2013. The pre-recruit fishing mortality rate index was at its highest level since 2004 during 2011 and 2012 but decreased by more than half in 2013. The percentage of the catch handled and released in the fishery decreased from 35 % in 2012 to 20 % in 2013, implying a decrease in pre-recruit mortality.

Discussion

Landings for the Div. 2HJ fishery were highest in the late 2000s and have declined to 2013. There was a sharp reduction in effort in 2HJ over the last two years. Complementing this, there was a sharp increase in all three CPUE indices in 2013. There is some scepticism on the reliability of these indices due to the sparse return of logbooks in this area. Because only 50 % of the logbook data was available at the time of the assessment, it is possible that the data used for the calculations was weighted toward earlier in the season when the catch rates are expected to be higher. The 2013 catch accumulated to approximately 500 tonnes before CPUE began to decline sharply. It is therefore imprudent to draw conclusions of a very sharp increase

in CPUE for this assessment based on the information available. When logbooks are added from the rest of the season the overall CPUE may decrease. This predication is based on a trend that after 6-8 weeks of fishing CPUE begins to decline and stay low.

Though the northern limit of distribution of the Div. 2HJ Snow Crab resource is around the lower part of the Nain Bank, the main centres of fishing activity for 2HJ tend to be in the Cartwright Channel and the Hawke Channel. A management line (54°40' line) splits the Cartwright Channel between two crab management areas. Quota is given to both North and South of the 54°40' line. In the area north of 54°N there has been an increased inability to take the Total Allowable Catch (TAC) despite a reduced TAC. The area south of 54°N has been able to take their TACs in any given year.

There was a sharp decrease in the area covered by the fishery in 2013. In the areas south of 54°40', the fishery became concentrated within the Hawke Channel area. CPUE increased substantially and trip duration decreased for this area.

There was a large decrease in fishing effort in the area north of 54°40' N (Cartwright area). In the Cartwright area the fishery was virtually abandoned in 2013. A comment from industry on why this occurred was that there was a high prevalence of soft-shell crab in Cartwright in 2013. Catch rates were high in the area but harvesters were hesitant to fish there and risk the recruitment for 2014. Fishers avoided Cartwright Channel in 2013 to avoid landing soft-shelled immediate pre-recruits. There are high hopes within industry that the Cartwright area will rebound in upcoming fishing seasons.

There was disagreement in the trends in exploitable biomass indices between the trap and trap surveys over the past few years. There appeared to be a subtle increase in the index from the trawl survey and a more substantial increase in that from the trap survey. Overall there is uncertainty in the current trend in the exploitable biomass. However, it was suggested that the trawl survey is likely the more reliable survey in this area because of limited and inconsistent annual coverage to date by the trap survey.

The recruitment in Div. 2HJ reached its most recent peak in 2011-2012 and has since been declining. There was a decrease in pre-recruit biomass in 2013 based on agreement between the post-season trawl and trap surveys. Long-term recruitment projections based on the environmental data suggests poor recruitment prospects upcoming in the short and long term.

A widely held belief that snow crab fisheries that open earlier in the season yield higher catch rates sparked the research recommendation that scientists examine the effect of fishery timing on depletion.

The Hawke Box closed area, which was established in 2003 and expanded to 50x50 nautical miles in 2004 to protect soft-shell and pre-recruit crab from shrimp trawling has not seen a difference of catch rates inside versus outside the area since its establishment.

AN ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB (*CHIONOECETES OPILIO*) IN 2013: OVERVIEW OF DIVISION 3K OFFSHORE

D. Mullowney, E. Dawe, K. Skanes, E. Hynick, W. Coffey, P. O'Keefe, D. Fiander, D. Stansbury, E. Colbourne, and D. Maddock Parsons.

Presenter – E. Dawe

Abstract

Landings most recently peaked at 13,300 t in 2009 but declined by 51 % to 6,500 t in 2012 before increasing to 6,600 t in 2013. Effort most recently peaked in 2009 and has since declined by 33 %. CPUE declined by half from 2008 to 2011 and increased slightly since 2012.

The exploitable biomass, as indicated by the post-season trap and trawl surveys, declined by more than two thirds since 2008. Recruitment declined after 2008 and prospects remain poor in the short term (2-3 years). Post-season pre-recruit biomass indices from both trap and trawl surveys have decreased by about 70 % since 2008. A recent warm oceanographic regime suggests weak recruitment in the long term. The trawl survey-based exploitation rate index was at its highest level since 2004 in 2010-2011. It decreased in 2012 before increasing again in 2013. The pre-recruit fishing mortality rate index increased from 2007 to 2011 but decreased in 2012 before increasing again in 2013. The percentage of the catch handled and released in the fishery decreased from about 20 % in 2012 to about 10 % in 2013, implying a decrease in pre-recruit mortality.

Discussion

Landings in relation to fishing effort peaked in Div. 3K offshore in 2009, declined steadily to 2012 and changed little in 2013. Effort in this area has declined from a peak in 2009 to 2013. TAC was reduced but was taken for the first time in several years.

The CPUE as indicated by all three indices decreased from a peak in 2008 to an extreme low in 2011 or 2012. It has since increased slightly indicating that fishery performance has improved marginally in 2013. No soft-shell crab was observed in the fishery in 2013. This coupled with low fishery performance is not a positive indicator for future recruitment in this area. The exploitable biomass index is clearly down to near the lowest level in both trap and trawl indices.

Catch rate as measured in numbers of snow crab per trap is low. It appears lower in numbers of crab than in weights because the crabs in this area are fairly large. Size-frequency distributions are flattened and there does not appear to be much coming through in terms of new recruits.

The last exploitable biomass peak in 2007-2008 was a result of a recruitment pulse. Since then there has been no evidence of a pulse of small crabs moving through the size frequency distribution. However there now appears to be a slight increase in the abundance of smallest crabs sampled by the trawl survey in 2013, although less pronounced than in Div. 2J.

The exploitation rate index, based on the landings in relation to the trawl survey exploitable biomass index of the previous year was down in 2012 and increased in 2013 to near its most recent peak. There was low prevalence of soft-shell crab in 2013; the lowest level on record as reported by the observers.

Negative signs in the data this year point to a biomass that is down, weak recruitment in the foreseeable future based on ocean climate trends, and little evidence of incoming recruitment in terms of moulting crabs that could contribute to the exploitable biomass.

In the Funk Island Deep closed area shrimp trawling is not allowed. In this area, as was shown in the Div. 2J Hawke Box, there appears to be no difference inside versus outside the closed area in crab catch rate.

A question was posed about the level of observer coverage compared to previous years. The observer coverage has changed only marginally over the past three years. It had decreased over the past five years down to a low level. It is second only to Div. 2J as lowest offshore area for observer coverage.

AN ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB (*CHIONOECETES OPILIO*) IN 2013: OVERVIEW OF DIVISION 3K INSHORE

D. Mullowney, E. Dawe, K. Skanes, E. Hynick, W. Coffey, P. O'Keefe, D. Fiander, D. Stansbury, E. Colbourne, and D. Maddock Parsons.

Presenter – E. Dawe

Abstract

Landings declined by 34 % from 2,900 t in 2009 to 1,900 t in 2012 and 2013. Effort increased by 70 % from 2008 to 2011 before declining by 40 % in 2013. CPUE declined by more than half from 2008 to 2011, and increased over the past two years. The exploitable biomass, as indicated by the post-season trap survey, decreased from 2007 to 2009 and has since fluctuated. Recruitment prospects are poor in the short term (2-3 years). The post-season trap survey pre-recruit biomass index decreased by more than half in 2013 to its lowest level in the time series. The post-season trap survey-based exploitation rate index has changed little throughout the time series. Data are insufficient to estimate the pre-recruit fishing mortality rate index.

Discussion

Landings in Div. 3K inshore most recently peaked in 2008-2009 and have since declined. The TAC was not taken this area from 2009-2012 but was in 2013. Effort had most recently peaked in 2011 and has decreased steadily in the past two years. CPUE had declined steeply from its most recent peak, down to 2011 and then increased in the past two years to 2013.

Div. 3K inshore has limited and inconsistent observer coverage among areas. In 2013, observer coverage was lower overall than in most years going back to 2003. There was particularly low observer coverage in White Bay.

The fishery started and finished early in 2013, finishing earliest of all recent years. The depletion trend over the 2013 season showed that catch rates held up throughout the season. The distribution of fishing effort within each of the crab management areas (CMAs) showed that 3D (Notre Dame Bay) is virtually an extension of 3K offshore and a part of the Funk Island Deep, Green Bay contains mostly shallower areas (not prime ground), and White Bay includes an area of deep water in the middle.

There was a decrease in the exploitable biomass from 2008-2009. Since then the exploitable biomass indices have fluctuated without trend. In 2013 however there is a decrease in exploitable biomass for all CMAs.

The pre-recruit biomass index decreased by more than half in 2013 in all three CMAs. The proportion by weight of older-shelled animals had increased up to 2012 but then decreased substantially in 2013. This decrease would appear larger if measured in number of crabs because these animals are generally very large in 2013 compared to previous years. There has overall been a clear decrease in recruitment recently.

Concern was raised that the decrease in exploitable biomass indices in 2013 was not evidence of the beginning of a decreasing trend but instead just one low number in a variable time-series. Concern was also raised that the exploitation rate index for inshore and offshore 3K were not comparable because they are produced from different sources of information, trap and trawl versus just trap. Though these numbers are not compared during the meeting or in the SAR, it was highlighted that it should be explicit in the SAR that these indices are not comparable. It may be sufficient to just comment on this the source of uncertainty section of the SAR.

AN ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB (*CHIONOECETES OPILIO*) IN 2013: OVERVIEW OF DIVISION 3LNO OFFSHORE

D. Mullaney, E. Dawe, K. Skanes, E. Hynick, W. Coffey, P. O'Keefe, D. Fiander, D. Stansbury, E. Colbourne, and D. Maddock Parsons.

Presenter – E. Dawe

Abstract

Landings decreased by 11 % from 24,500 t in 2006 to 21,900 t in 2009 and then increased by 20 % to 26,300 t in 2013. Effort increased by 83 % from 2000 to 2008 and has since declined by 32 %. VMS-based CPUE declined to its lowest level in 2008, and has since increased steadily to its highest level in the time series. The indices of exploitable biomass from post-season trap and trawl surveys diverged during 2009 to 2011 with the trap index increasing and the trawl index declining. However both indices have since increased slightly. Biological data from several sources indicate that recruitment will likely decrease in the short term. A recent warm oceanographic regime suggests weak recruitment in the long term. The exploitation rate index decreased marginally in 2013. The pre-recruit fishing mortality rate index decreased from 2008 to 2011, increased in 2012 and changed little in 2013. The percentage of the catch handled and released in the fishery decreased from about 20 % in 2008 to 9 % in 2013, implying a decrease in pre-recruit mortality.

Discussion

Div. 3LNO offshore combines several divisions but is managed as a unit. The offshore is divided into many CMAs. The landings reached a low in 2009 and then began to increase again. Landings have changed little over the past three years and are at their highest level since the 1999 peak. Fishing effort in this area has declined since 2008. Since 2008 there has been a steep improvement in fishery performance reflected by an increase in CPUE in all three indices.

In 2013 the fishery performed very well throughout the season, as is typical of this area. This trend is evident in relation to the cumulative catch. There is no evidence of depletion throughout the season as the removals continue to be drawn from this resource. This implies a relatively low exploitation rate in this area relative to other areas. Logbook data are generally complete here.

The spatial distribution of fishing effort is generally consistent among years. As the CPUE has increased in the past few years, the area fished decreased. This indicates that the resource is in healthy condition and harvesters are not fishing extensive grounds to take quota.

There has been very little soft-shell crab encountered in Div. 3LNO offshore. This was a concern in other areas but in this area soft-shell crab is not often encountered so this does not appear to be an indicator of poor recruitment.

The size-frequency distributions from observer at-sea sampling and from the post-season trap survey, broken down by shell condition, show a trend of increased recruitment during about 2008-2010. This increase in recruitment was reflected by a shift in size frequency distributions to smaller size, with the most abundant size class at the minimum legal size, due to the entry of recently-molted crabs into the exploitable biomass. In 2013, these crabs have become very large, indicating that the recruitment pulse has now progressed well into the legal size range. The average size of legal-sized snow crabs is considerably larger than it was in 2008; this is especially evident in the post-season trawl survey size frequencies.

It was noted that the most plausible explanation for the divergence of the trap and trawl exploitable biomass indices during 2009-2011 was inflated trawl survey estimates from the trawl

survey during 2008-2010. This was reflected in higher abundance indices across the full trawl survey size range for that period compared to the years immediately before (2007) and after (2011). The trap survey series was believed to better indicate the true trend in exploitable biomass throughout recent years because it agreed with the trend in fishery performance (CPUE).

The current high exploitable biomass was generated from a large pulse of crabs that first appeared as pre-recruits in 2008 and continued to be harvested in the fishery to 2013. Most of this group has now achieved terminal moult. There is an expectation of weaker recruitment to the exploitable biomass in the near future. While there was considerable debate and some disagreement about the likelihood of such an imminent recruitment decline most participants agreed that this was likely. Support for this conclusion included the observation that the recent recruitment pulse has now fully entered the exploitable biomass, and the abundance of pre-recruits (adolescents >75 mm CW) from the 2013 trawl survey was very low. Also, the abundance of smallest crabs (<40 mm CW) from the trawl survey has remained low since 2003. Although a modal group of small crabs was detected by small-meshed traps in the post-season trap survey during 2012 and 2013, these catches were localized and several years from recruitment.

Fishery catch rates remain high in this area relative to other areas. Catch rates in this area seldom decline below 7 kg/trap haul. Because of this, a high prevalence of soft-shell crab is not encountered as the residual biomass does not become depleted, thereby maintaining strong competition against soft-shelled crabs for baited traps.

Overall since the mid-1990s there has been progressive warming to a record high temperature in 2011. This implies weak recruitment in the long-term.

AN ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB (*CHIONOECETES OPILIO*) IN 2013: OVERVIEW OF DIVISION 3L INSHORE

D. Mullooney, E. Dawe, K. Skanes, E. Hynick, W. Coffey, P. O'Keefe, D. Fiander, D. Stansbury, E. Colbourne, and D. Maddock Parsons.

Presenter – E. Dawe

Abstract

Landings increased by 19 % from 6,100 t in 2005 to 7,300 t in 2010, and have since changed little, at 7,600 t in 2013. Effort increased from 2008 to 2010 and has since declined steadily. CPUE increased sharply since 2011 to its highest level. The post-season trap survey index suggests that the exploitable biomass increased steadily since 2008 to its highest level in the time series, with considerable variability among management areas. Recruitment has declined slightly since 2010, although there is considerable variability among management areas, and is expected to decline further in the short-term (2-3 years). The post-season trap survey pre-recruit biomass index decreased in 2013. The post-season trap survey-based exploitation rate index has changed little over the time series, with considerable variability among management areas. Data are insufficient to estimate a pre-recruit fishing mortality rate index.

Discussion

Landings in Div. 3L inshore increased slightly from 2011 to 2013. Effort has decreased steadily from 2010. As a result of this gradual increase in landings but sharp decrease in effort, a large increase in CPUE was observed that has reached an all-time high.

Total observer coverage in this area has decreased and the spatial pattern of observer coverage changed in 2013. Observer coverage occurred disproportionately in CMA 8A compared to in other areas.

The onset of the fishery was early in 2013. CPUE stayed high throughout the season, comparable with 2012, and higher than in other recent years. The pattern of an inverse relationship between CPUE and area fished was maintained with a big increase in CPUE related to a decrease in area fished in recent years. There has been a large improvement in fishery performance over the past three years particularly in Conception Bay. The post-season trap survey shows a steady increase in the exploitable biomass since 2008, although there was some variability among management areas.

The pre-recruit biomass index from the post-season trap surveys had been increasing to 2012. In 2013, for the first time in several years, there was a substantial decrease in the biomass of undersized crabs. There had been an increasing proportion of sub-legal crabs that were old-shelled over the time-series, likely reflecting an increase in the proportion terminally-molted (adults) and hence not true pre-recruits. The decrease in pre-recruit biomass index observed in 2013 likely reflects a true decrease in biomass because there was little change in the proportion old-shelled.

The post-season trap survey shell condition composition shows that the catch rate of older-shelled crabs has been increasing in the past two years. This followed a slight decline in recruitment since a 2010 peak. Overall catch rates have remained high, indicating that the exploitation level has not been excessive.

AN ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB (*CHIONOECETES OPILIO*) IN 2013: OVERVIEW OF SUBDIVISION 3PS OFFSHORE

D. Mullowney, E. Dawe, K. Skanes, E. Hynick, W. Coffey, P. O'Keefe, D. Fiander, D. Stansbury, E. Colbourne, and D. Maddock Parsons.

Presenter – D. Mullowney

Abstract

Landings almost doubled from 2,300 t in 2006 to a peak of 4,200 t in 2011, before declining by 16 % to 3,500 t in 2013. Effort increased by 76 % from 2008 to a record high level in 2013. CPUE increased from 2005 to 2009 and has steadily declined since, to about its previous lowest level. The exploitable biomass, as indicated by both the spring trawl survey and the post-season trap survey indices, increased steadily from 2006 to 2009 before declining rapidly to its lowest level in 2013. Recruitment has recently declined and is expected to decline further in the short term (2-3 years). Pre-recruit biomass indices from both trap and trawl surveys declined rapidly from 2009 to their lowest levels in 2013. A recent warm oceanographic regime suggests weak recruitment in the long term. The spring trawl survey-based exploitation rate index more than doubled from 2009-2012, before doubling again in 2013. The pre-recruit fishing mortality rate index has increased steadily since 2009 to about its previous highest level.

Discussion

The presentation described a resource in steep decline with a sharp increase in exploitation rate over the past 4 years, and especially in 2013. This situation was not disputed during the limited discussion following the presentation.

It was noted that size frequencies from the post-season trap survey small-meshed traps showed the appearance of a modal group of very small adolescents in the past two years, as was also

evident in the western-most small-meshed traps in Div. 3LNO; the Whale Deep area of Div. 3O. However this group was not as prominent in offshore Subdiv. 3Ps, as it was in Div. 3O.

**AN ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB
(*CHIONOECETES OPILIO*) IN 2013: OVERVIEW OF SUBDIVISION 3PS INSHORE**

D. Mullowney, E. Dawe, K. Skanes, E. Hynick, W. Coffey, P. O'Keefe, D. Fiander, D. Stansbury, E. Colbourne, and D. Maddock-Parsons.

Presenter – D. Mullowney

Abstract

Landings more than tripled from 700 t in 2005 to 2,500 t in 2011 and remained at that level since. Effort declined substantially in 2005 and has since varied without trend. CPUE increased steadily from 2005 to 2010, changed little in 2011–2012, and then decreased slightly in 2013. The exploitable biomass, as indicated by the post-season trap survey index, increased substantially between 2006 and 2010, changed little in 2011–2012, and then decreased by half in 2013. Recruitment decreased substantially in 2013 and is expected to remain low in the short term (2–3 years). The pre-recruit biomass has been declining since 2007. The post-season trap survey-based exploitation rate index has changed little in the past six years. Data are insufficient to estimate a pre-recruit fishing mortality rate index.

Discussion

Effort in Subdiv. 3Ps inshore decreased substantially in 2004 and has since remained at a low level. The trend in the overall landings is largely dominated by the fishery in Placentia Bay. There has been no change in TAC or landings over the past three years. The CPUE decreased slightly in 2013 following a fairly high level over the previous four years.

The shell composition of undersized and legal-sized crabs has been dominated by old-shelled crabs over the last three years. In recent years there has been no signal of adolescents appearing and moving through the size-frequency distribution. The size-frequency distributions from small-meshed traps remain dominated by undersized adults. Fortune Bay was reopened with TAC in 2011, following a period when it was exploited by a monitoring fishery. Landings and CPUE have not changed much in Fortune Bay since 2007.

Management Area 11W, like Fortune Bay, had been exploited only by a monitoring fishery for quite some time, with no fishing in some years (2005–2007). The fishery was reopened with TAC in 2011. Landings have generally changed little since 2009. Effort last peaked in 2011 and since declined to 2013.

**AN ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB
(*CHIONOECETES OPILIO*) IN 2013: OVERVIEW OF DIVISION 4R OFFSHORE**

D. Mullowney, E. Dawe, K. Skanes, E. Hynick, W. Coffey, P. O'Keefe, D. Fiander, D. Stansbury, E. Colbourne, and D. Maddock Parsons.

Presenter – E. Dawe

Abstract

Landings declined by 83 % from 190 t in 2007 to a historical low of 30 t in 2010, and increased to 300 t in 2013. Effort increased by almost a factor of 7 since 2010. The TAC has not been taken since 2002. VMS-based CPUE declined from 2004 to its lowest level in 2009 before increasing to its highest value in the time series in 2013. The exploitable biomass remains low relative to other areas. Recruitment prospects are uncertain in the short term (2–3 years). A

recent warm oceanographic regime suggests weak recruitment in the long term. Data are insufficient to calculate the exploitation rate and pre-recruit fishing mortality rate indices.

Discussion

Both surveys that contribute data to assess Div. 4R offshore were incomplete in 2013. This leaves very fragmented data upon which to base an assessment.

Landings have been increasing steadily from a low in 2010 to the point where it is close to achieving the TAC. Effort has also increased over that period. Logbook-based CPUE has increased steeply in the past two years to its highest level since 2002.

Fishing effort is mostly concentrated at the boundary with inshore areas and the only true offshore fishery is in the deep waters adjacent to Port Aux Choix. The trend in timing of the fishery was not much different than in other years. The trend in catch rates throughout the season shows the effect of depletion throughout the season.

The relationship of the CPUE with a temperature index shows a trend similar to what we see in every other area. The temperature lag of best fit appears to be 5 years in this area. The lag is shorter in this area than others, which makes sense because it is the warmest area. Recent years have been warming leading to the prediction that long term recruitment prospects are not favourable.

The data collected from this area were not sufficient to conduct a credible assessment. The TAC is fished by a few participants and is rarely achieved. There is a program in place whereby harvesters may pay a base fee and are not required to fish crab each year. Crab is not a priority fishery in this area and the TAC has not been limiting. The position from the fishers in the area is to leave the TAC at its current level. By maintaining the current TAC, individual quotas can remain at the current level for the benefit of those who choose to participate in the fishery.

AN ASSESSMENT OF NEWFOUNDLAND AND LABRADOR SNOW CRAB (*CHIONOECETES OPILIO*) IN 2013: OVERVIEW OF DIVISION 4R INSHORE

D. Mullowney, E. Dawe, K. Skanes, E. Hynick, W. Coffey, P. O'Keefe, D. Fiander, D. Stansbury, E. Colbourne, and D. Maddock Parsons.

Presenter – D. Mullowney

Abstract

Landings declined by 80 % from 930 t in 2003 to a historical low of 160 t in 2010 and have since more than tripled to 600 t in 2013. Effort declined by 69 % from 2004 to 2010 and doubled in 2011 before declining by 34 % to 2013. The TAC has not been taken since 2002. CPUE increased sharply since 2010 to a record high level in 2013. The exploitable biomass, as indicated by the post-season trap survey index, fluctuated from 2006 to 2010, was three times as large in 2011, and changed little in 2012 before decreasing in 2013. Recruitment prospects are unfavorable in the short term (2-3 years). The trap survey pre-recruit biomass index more than doubled in 2009 and changed little until it decreased substantially to remain below pre-2009 level during 2012-2013. The post-season trap survey-based exploitation rate index decreased in 2012 and changed little in 2013. Data are insufficient to estimate a pre-recruit fishing mortality rate index.

Discussion

Div. 4R inshore contains a number of management areas. The data are limited for areas 12A and 12B. 12C (Bay St. George) drives most of the trends in the data for Div. 4R inshore.

There has been a recent pulse of recruitment in the last few years that has resulted in recovery of the fishery across all CMAs. The pattern of effort reflected a fishery that was increasingly abandoned up until 2010. Since then effort increased as recruitment increased and the resource improved in most areas. Most of the TAC was taken in 2013.

CPUE was at an all-time high in 2013 following the low level during 2007-2011. Timing of the fishery was normal and began in the first week of April and finished quickly within a few weeks. CPUE was high through all weeks of the season. Logbook returns were low, as is typical for this area.

The size-frequency distributions showed that the recruitment pulse seems to be dissipating following the progression of the pre-recruits into the exploitable biomass. The fishery capitalized on this recruitment. In each year since 2010 nearly all of the crabs were new-shelled. This infers that the fishery was reliant on harvesting the incoming recruitment from one year to the next. There has not been a significant buildup of old-shelled crabs.

Exploitation rate indices by management area were highly variable. The overall trend was largely driven by CMA 12C (Bay St. George). Bay St. George followed the overall pattern of going from a small fishery in the late 2000s to an expanded fishery recently.

CMA 12B (Port au Port Bay) followed the same pattern. This area was virtually abandoned in the late 2000s but has recovered in recent years with increasing effort; 12E and 12F (The Bay of Islands) followed a similar pattern.

CMA 12G (Bonne Bay) was under a self-imposed moratorium in 2009 and 2010 and reopened in 2011. Fishers in this area took the TAC in 2013. This area is now experiencing an all-time low in effort expenditure together with high CPUE such that the TAC was taken in only a couple of weeks. The CMA 12H fishery followed a similar trend to that of the other areas.

CANADIAN PRECAUTIONARY APPROACH OVERVIEW

P. Shelton

Presenter – P. Shelton

Abstract

The Precautionary Approach in fisheries management originated in the 1995 United Nations Fish Stocks Agreement, which introduced the notion of the Limit Reference Point. This denotes a level of spawning stock biomass or fishing mortality that should be avoided with high probability to ensure that serious harm is not done to the stock. DFO has recently introduced a Sustainable Fisheries Framework (SFF) for the management of fish stocks, which incorporates a Precautionary Approach framework. The framework recognizes three zones based on spawning stock biomass – Healthy, Cautious and Critical. The Critical Zone is below the limit reference point and is to be avoided. In the Cautious Zone, fishing mortality should be reduced to return the stock to the Healthy Zone. The management target is in the Healthy Zone. Fishing mortality should not exceed F_{msy} in the Healthy Zone and should decrease if the stock declines through the Cautious Zone. It is not clear how the SFF should be applied to snow crab at this stage given its particular life history and the nature of the fishery. Approaches taken for a number of other snow crab stocks were reviewed and discussed. The suggestion was made that there should be a special CSAS meeting to develop the precautionary approach for snow crab with participants to include invited external experts.

Discussion

To move forward with the precautionary approach in Newfoundland and Labrador it is necessary to have a stand-alone scientific meeting (research recommendation). Participants

would need to be representative of science and management as well as industry. A three step process would be advisable: (1) first involving scientists, then (2) bringing in managers, and finally (3) industry and environmental groups joining the discussion.

The issue of stock structure should be addressed before moving forward with the precautionary approach. Application of the precautionary approach to every crab management area would be difficult. It may be better to assess the resource as a single biological unit.

The importance of assessing biological units rather than management units was discussed. It was noted that biological units are not necessarily genetically discrete units. Gene flow between two components of a single population (eg. through larval drift) can be sufficient to prevent genetic segregation but insufficient to result in one component affecting the performance of the other. In that case management units may represent biological units but not separate stocks and it might be appropriate to manage the resource based on management units.

For a Newfoundland Snow Crab precautionary approach the management objectives need to be defined so they can be converted into measurable performance statistics. Harvest control rules need to be set up.

Use of SSB reference points can be survey based, model-based, exploitable biomass-pre-recruit based or stock production based. A number of the simulation models for testing harvest control rules have included stock- recruit functions. SSB limit reference points are needed in the DFO framework but do not have to be connoted as a stopping rule. It is important that if levels fall below the SSB limit reference point that there is then zero tolerance for preventable further decline.

Marine Stewardship Council (MSC) is a driver for ensuring that reference points are established. MSC does not require harvest control rules to be simulation tested. However it is essential to have some idea of whether a harvest control rule will achieve the management objective given uncertainty.

Finally harvest control rules need to be implemented. Once that point is reached, this can amount to plugging in the data and establishing the TAC. Fisheries managers would not have to wonder what the TAC is going to be because it would be set by the harvest control rule.

SNOW CRAB CPUE DEPLETION PRELIMINARY RESULTS

N. Cadigan and S. Lelièvre

Presenter – S. Lelièvre

Abstract

Snow crab (*Chionoecetes opilio*) fisheries are economically very important in Newfoundland and Labrador, contributing 33 % to the provincial total landed value in 2013. This fishery has recently been MSC certified with requirements for reference points and harvest control rules. The main objective of this study was to estimate stock biomass and harvest rates to better understand population dynamics and to provide inputs to future harvest control rules. A depletion model was developed for catch-per-unit-effort (CPUE) data during 1990-2012 and for the spatial fishing zones used for stock assessment. The model included an effect for pot saturation. The model was estimated using the `nls()` function in R. This function performs nonlinear least squares estimates, and it was used to estimate total biomass, CPUE catchability (q), harvest rate, and recruited biomass. Profile likelihood confidence intervals were computed for model parameters, except for parameter estimates at boundary constraints. We fixed these intervals at wide values. The fit of the model was better after 2000 because of higher levels of

effort and depletion in this period. This resulted in tighter confidence intervals for stock biomass after 2000. Results indicate that stock biomass has declined over time for all regions combined, and that harvest rates have increased and are higher in NAFO Divisions 2HJ3K than in 3LNO. Results were consistent with survey data presented during the meeting.

Discussion

It was noted that by including the survey biomass indices, this work might lose some of its value as it would no longer produce independent estimates. The response to this was that an assessment objective should be to produce a single best estimate that integrates all relevant data and information on stock dynamics. A concern was raised that this model would not be useful for areas such as 3LNO where depletion is not observed over the fishing season.

Concern was raised that this tool may be assessing depletion in local areas that are highly targeted by the fishery but may not be assessing the depletion of the whole of the population. This would violate the assumption in the model that the sample is well mixed and may make sense if adult snow crabs are not very mobile. If this is the case, there would have to be large areas with high abundances of crab that are not being fished. This is a more general problem with catch-based stock assessment.

The cause of pot saturation was discussed. Model estimates suggested that once a trap has around 25 kg or 50 lbs of crab then it ceases to fish. Possible reasons for this are that the bait in the pot simply wears off over time, undersized crab eat the bait, etc. It was eventually recognized that the exact mechanisms that would generate pot saturation are unknown but crab pots do not catch crab indefinitely. They reach a saturation point. However, some meeting participants did not feel that pot saturation was an important effect for the soak times that are typical in the fishery.

A DISCUSSION ABOUT METHODS FOR CALCULATING BIOMASS IN NL SNOW CRAB – FOCUS ON 2J EXPLOITABLE BIOMASS

D. Mullowney

Presenter – D. Mullowney

Abstract

Multiple independent projects have recently developed biomass indices from trap and trawl-based data sources for snow crab in Newfoundland and Labrador. Some of these projects have been undertaken as first-step initiatives toward establishing a precautionary approach framework for this resource, while others have resulted from ongoing refinement of assessment techniques. This discussion served as a comparison of methodologies and results, discussed pros and cons of each, and elaborated on possible approaches to employ moving forward. It was found that all techniques were generally similar in trend with differences occurring in the magnitude and error structure of annual estimates. An outline of future directions was presented to assist researchers in further refining and combining their methodologies toward a collaborative pursuit of establishing absolute biomass for the Newfoundland and Labrador snow crab resource.

Discussion

By comparison, OGMAP (OGive MAPping) is more accommodating to holes in time and space than the STRAP (STratified Random Assessment Process) analysis. Because the trap survey is a fixed station design, when plugging the data into the STRAP analysis, the random assumption is immediately violated. Fixed station design is probably not an adequate design. OGMAP can accommodate nearly any sampling design.

There are a variety of smoother approaches and OGMAP is one. One problem with the smoothers is that if two tow locations of the same depth are close together in space but have a big mound between them, it would interpret them as being the same distance apart as two locations that have nothing in between. It is like computing the distance between two points along the coast. For example, if a location on the head of Placentia Bay, the distance from the head of Placentia Bay to the head of Trinity Bay is not the direct measure of distance. Marine organisms would have to swim around obstacles. In a STRAP type analysis this can be taken into account crudely via stratification.

Another issue is filling in missing strata. Probably the best method for this would be to use information from other years.

OGMAP estimates tend to be a little bit higher than STRAP estimates. This could be related to the Div2J-3K border. There tend to be a lot of crabs south of that area. OGMAP will take survey information from outside the area it is integrating over. OGMAP integrates the mean to get a biomass estimate and is a right skewed distribution.

GENERAL PA DISCUSSION

A trend for best practice for resource assessment is an integrated analysis. This takes all of the information and extracts the overall signal from it. All available information is included in trying to provide the best estimate of resource size and productivity. In the literature it is called an integrated modelling approach. In this we would use the depletion information, logbook information, trap survey information, the trawl survey information and whatever else is available. This information is assembled to try to come up with a best estimate. The downside of it is that these integrated models tend to be hard to run.

RESEARCH RECOMMENDATIONS

- An analysis of shell-age composition that is focused specifically on survey data from highly fished areas to look for evidence of fishery induced effect.
- An analysis of shell-age composition for all the stock assessment areas for Newfoundland and Labrador Snow crab.
- Investigate if shorter overall ontogenetic migration route has an effect on crab survival. Factor this into long-term recruitment prospects for different areas.
- Investigate whether fisheries that open earlier in the season yield higher catch rates. Investigate effect of fishery timing on depletion.
- Host a stand-alone meeting on the precautionary approach in NL with science, management, industry, environmental groups. Bring in quantitative experts.
- Investigate the exact mechanisms in snow crabs that generate trap saturation.
- Examine Campelen survey behaviour on different substrates. This may occur by testing whether snow crabs in trap surveys have a catchability independent of bottom type. Follow this with nearest neighbor analysis of trap versus Campelen trawl and how it is affected by bottom type.

APPENDIX I: TERMS OF REFERENCE

Newfoundland and Labrador Snow Crab Assessment

Regional Peer Review Process - Newfoundland and Labrador Region

February 18-20, 2014

St. John's, NL

February 25-27, 2014^[1]

St. John's, NL

Chairperson: Dawn Maddock Parsons

Context

The status of Div. 2HJ3KLNO, Subdiv. 3Ps and Div. 4R Snow Crab was assessed in 2013. The current assessment of the stock components was requested by Fisheries Management to provide current information on the status of the resource and to provide the data that will be used in the 2014 Snow Crab Management Plan.

Objectives

- To assess the status of snow crab resource: Divisions 2HJ3KLNO4R;
- To determine the impact of maintaining the current harvest levels; and
- To investigate the use of reference points for the development of a precautionary approach framework for the management of snow crab in the NL Region.

Expected publications

- Science Advisory Report
- Meeting Proceedings
- Research Document
-

Participation

- Fisheries and Oceans Canada (DFO) Science and Fisheries Management
- Province of Newfoundland and Labrador Department of Fisheries and Aquaculture
- Academia
- First Nations
- Fishing Industry
- Other invited experts

[1] February 25-27 will be used to finalize the complete text of the Science Advisory Report. All attendees are invited to participate. Summary bullets for each stock will be agreed upon in plenary during the February 18–20, 2014 meeting.

APPENDIX II: AGENDA

AGENDA

Newfoundland and Labrador Regional Peer Review Meeting:
Assessment of Snow Crab
Hampton Inn
St. John's, Newfoundland & Labrador
February 18-20, 2014

Northwest Atlantic Fisheries Centre, 80 East White Hills Road
St. John's, Newfoundland & Labrador
February 25-27, 2014

Chair: Dawn Maddock Parsons

Tuesday, February 18		
09:00	Preliminaries and greetings from the Chair	Dawn Maddock Parsons
09:30	Oceanographic Overview	Eugene Colbourne
10:00	Inferring exploitation rates from the distribution of ages of hard shells of adult crabs	Geoff Evans
10:30	<i>BREAK</i>	
10:45	Divisions 2HJ3KLNOP4R Overview and Science Advisory Report Bullets	Darrell Mallowney
11:15	Division 2HJ and Science Advisory Report Bullets	Darrell Mallowney
12:15	<i>LUNCH</i>	
13:15	Division 3K Offshore Science Advisory Report Bullets	Earl Dawe
15:00	<i>BREAK</i>	
15:15	Division 3K Inshore and Science Advisory Report Bullets	Earl Dawe
17:00	<i>ADJOURN</i>	

Wednesday, February 19		
09:00	Division 3LNO Offshore	Earl Dawe
10:30	<i>BREAK</i>	
10:45	Division 3LNO Offshore Science Advisory Report Bullets	Earl Dawe
12:00	<i>LUNCH</i>	
13:00	Division 3L Inshore and Science Advisory Report Bullets	Earl Dawe
15:00	<i>BREAK</i>	
15:15	Subdivision 3Ps Offshore and Science Advisory Report Bullets	Darrell Mallowney
17:00	<i>ADJOURN</i>	

Thursday, February 20		
09:00	Sub-division 3Ps Inshore Science Advisory Report Bullets	Darrell Mallowney
10:30	<i>BREAK</i>	
10:45	Division 4R Offshore and Inshore and Science Advisory Report Bullets	Earl Dawe
12:00	<i>LUNCH</i>	
13:00	Depletion methodology	Noel Cadigan
13:30	Comparison of Methods for Determining Biomass	Darrell Mallowney
14:00	Canadian Precautionary Approach Overview	Peter Shelton
14:30	Precautionary Approach Discussion	ALL
15:00	<i>BREAK</i>	
15:15	Precautionary Approach Discussion (cont'd)	ALL
16:45	Research Recommendations	
17:00	<i>ADJOURN</i>	

Tuesday, February 25, (NWAFC)	
09:00-17:00	Drafting of SARs (All stock areas)
Wednesday, February 26, (NWAFC)	
09:00-17:00	Drafting of SARs (All stock areas)
Thursday, February 27, (NWAFC)	
09:00-17:00	Drafting of SARs (All stock areas)

APPENDIX III: LIST OF PARTICIPANTS

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APPENDIX IV: LIST OF WORKING PAPERS PRESENTED

- Oceanographic Overview: Physical Oceanographic Environment on the Newfoundland and Labrador Shelf, update for 2013. Colbourne, E., Craig, J., Fitzpatrick, C., Senciall, D., Stead, P., and Bailey, W.
- Inferring exploitation rates from the distribution of ages of hard shells of adult crabs. Evans, G.
- An Assessment of Newfoundland and Labrador Snow Crab (*Chionoecetes opilio*) in 2013. Mullooney, D., Dawe, E., Skanes, K., Hynick, E., Coffey, W., Fiander, D., Stansbury, D., Colbourne, E., and Maddock Parsons, D.
- Canadian Precautionary Approach Overview. Shelton, P.
- Snow crab CPUE depletion preliminary results. Cadigan, N., and Lelièvre, S.
- A Discussion About Methods for Calculating Biomass in NL Snow Crab – Focus on 2J Exploitable Biomass. Mullooney, D.